Table of Contents ..... **Error! Bookmark not defined.**
Chapter 40 ..... **Error! Bookmark not defined.**
**Section** ..... **Error! Bookmark not defined.**
Chapter Forty ..... 3
40-1.0 HIGHWAY SYSTEMS ..... 3
40-1.01 Functional Classification System ..... 3
40-1.01(01) Arterials ..... 3
40-1.01(02) Collectors ..... 4
40-1.01(03) Local Roads and Streets ..... 5
40-1.01(04) Recreational Roads ..... 5
40-1.02 Urban Design Subcategories (by Type of Area) ..... 5
40-1.03 Federal-Aid System ..... 7
40-1.03(01) National Highway System ..... 7
40-1.03(02) Surface Transportation Program ..... 8
40-1.03(03) Bridge Replacement and Rehabilitation Program ..... 9
40-1.04 Jurisdictional System ..... 9
40-1.04(01) State Highway System ..... 9
40-1.04(02) County Road System ..... 9
40-1.04(03) City Road and Street System ..... 9
40-1.04(04) DNR Recreational Roads ..... 10
40-1.05 National Truck Network ..... 10
40-2.0 TRAFFIC VOLUME CONTROLS ..... 10
40-2.01 Definitions ..... 11
40-2.02 Design Year Selection ..... 12
40-2.02(01) Roadway Design ..... 12
40-2.02(02) Other Highway Elements ..... 13
40-2.03 Design Hourly Volume Selection ..... 14
40-2.04 Capacity Analyses ..... 14
40-2.04(01) Objective ..... 14
40-2.04(02) Responsibility ..... 15
40-3.0 SPEED ..... 15
40-3.02 Design Speed Selection ..... 17
40-3.02(01) Geometric Design Considerations ..... 17
40-3.02(02) Regulatory Speed vs. Design Speed ..... 18
40-3.02(03) Legal Speed Limits ..... 19
40-4.0 VEHICULAR CHARACTERISTICS ..... 21
40-5.0 ACCESS CONTROL (Definitions) ..... 21
40-6.0 PROJECT SCOPE OF WORK ..... 22
40-6.01 Definitions ..... 22
40-6.01(01) New Construction ..... 22
40-6.01(02) Complete Reconstruction (Freeways) ..... 23
40-6.01(03) Partial Reconstruction (4R) (Freeways) ..... 23
40-6.01(04) Reconstruction (4R) (Non-Freeways) ..... 24
40-6.01(05) 3R Projects (Freeways) ..... 25
40-6.01(06) 3R Projects (Non-Freeways) ..... 26
40-6.01(07) Partial 3R Projects ..... 28
40-6.01(08) High-Accident Location Improvements (Non-Freeways) ..... 28
40-6.01(09) Traffic Control Device Projects ..... 29
40-6.02 Application ..... 29

40-6.02(01) National Highway System (NHS) Projects ..... 29
40-6.02(02) Non-NHS Projects ..... 30
40-6.02(03) Procedures ..... 32
40-7.0 FHWA INVOLVEMENT ..... 33
40-8.0 ADHERENCE TO DESIGN CRITERIA ..... 34
40-8.01 Department Intent ..... 34
40-8.02 Hierarchy of Design Criteria ..... 34
40-8.02(01) Level One ..... 34
40-8.02(02) Level Two ..... 35
40-8.02(03) Level Three ..... 36
40-8.03 Design Exception Process ..... 37
40-8.04 Procedures for Design Exceptions (Level One) ..... 38
40-8.04(01) Department Procedures ..... 38
40-8.04(02) FHWA Procedures ..... 41
40-8.04(03) Procedures for the Defense Highway Network (Interstate System) – Vertical Clearance ..... 41
40-8.04(04) Procedures for Local Projects (with Federal Funds) ..... 42
40-8.04(05) Procedures for 100% Local Projects ..... 43
40-8.04(06) Signature Block ..... 43
40-8.05 Documentation ..... 43

## List of Figures

| Figure | Title |
|---|---|
| 40-1A | (Deleted) |
| 40-1B | National Truck Network in Indiana |
| 40-2A | Recommended Design Year Selection (Traffic Volumes for Road Design) |
| 40-2B | Measures of Effectiveness for Level of Service |
| 40-3A | Legal Speed Limits |
| 40-4A | Design Vehicle Dimensions |
| 40-4B | Basic Dimensions of Design Vehicle (Combination Truck A) |
| 40-4C | Basic Dimensions of Design Vehicle (Combination Truck B) |
| 40-6A | 3R/4R Systems |
| 40-7A | FHWA Involvement (ISTEA) |
| 40-7B | (Deleted) |
| 40-8A | MTMCTEA Design Exception Request Letter |
| 40-8B | Level One Design Criteria Checklist |

*Chapter Forty*

# BASIC DESIGN CONTROLS

## *40-1.0 HIGHWAY SYSTEMS*

### 40-1.01 Functional Classification System

The functional classification concept is one of the most important determining factors in highway design. In this concept, highways are grouped by the character of service they provide. Functional classification recognizes that the public highway network in Indiana serves two basic and often conflicting functions - access to property and travel mobility. Each highway or street will provide varying levels of access and mobility, depending upon its intended service. In the functional classification scheme, the overall objective is that the highway system, when viewed in its entirety, will yield an optimum balance between its access and mobility purposes. If this objective is achieved, the benefits to the traveling public will be maximized.

The functional classification system provides the framework for determining the geometric design of individual highways and streets. Once the function of the highway facility is defined, the highway designer can select an appropriate design speed, roadway width, roadside safety elements, amenities and other design values. *Indiana Design Manual* Part V is based upon this systematic concept of determining highway design.

The Program Development Division's Highway Statistics Section has functionally classified all public highways and streets within Indiana. To design a project, it is necessary to determine the predicted functional class of the highway or street for the selected design year (e.g., 20 years beyond the project completion date). Typically, the functional class of the facility is identified in the Engineer's Report prepared by the Environment, Planning and Engineering Division. See Chapter Five.

### 40-1.01(01) Arterials

Arterial highways are characterized by a capacity to quickly move relatively large volumes of traffic and an often restricted function to serve abutting properties. The arterial system typically provides for high travel speeds and the longest trip movements. Rural arterials provide connections between the major urban areas and provide a level of service suitable for statewide or interstate travel. The rural arterial system provides integrated, continuous movements without the need for stub connections.

In urban areas, the arterial system provides these functions: (1) It serves the major centers of activity within the urban area; (2) it carries the highest traffic volumes and longest trip movements; and (3) it serves both major intra-city and through trips. The rural and urban arterial systems are connected to provide continuous through movements at approximately the same level of service.

The arterial functional class is subdivided into principal and minor categories for rural and urban areas:

1. Principal Arterials. In both rural and urban areas, the principal arterials provide the highest traffic volumes and the greatest trip lengths. Principal arterials can be further subdivided into the following classifications:

    a. Freeways. The freeway, which includes Interstate highways, is the highest level of arterial. These facilities are characterized by full control of access, high design speeds, and a high level of driver comfort and safety. For these reasons, freeways are considered a special type of highway within the functional classification system, and separate design criteria have been developed for these facilities.

    b. (Other) Principal Arterials/Expressways. These facilities may be 2 or 4 lanes with or without a median. Partial control of access is desirable along these facilities and, if a divided highway, this is termed an expressway. In many cases, the level of geometric design is equivalent to that of freeways (e.g., 3.6-m lane widths are required on all principal arterials).

2. Minor Arterials. In rural areas, minor arterials will provide a mix of interstate and interregional travel service. In urban areas, minor arterials may carry local bus routes and provide intra-community connections, but they will not, for example, penetrate neighborhoods. When compared to the principal arterial system, the minor arterials provide lower travel speeds, accommodate shorter trip lengths and lower traffic volumes, but they provide more access to property.

**40-1.01(02) Collectors**

Collector routes are characterized by a roughly even distribution of their access and mobility functions. Traffic volumes and speeds will typically be somewhat lower than those of arterials. In rural areas, collectors serve intra-regional needs and provide connections to the arterial system. All cities and towns within a region will be connected. In urban areas, collectors act as intermediate links between the arterial system and points of origin and destination. Urban

collectors typically penetrate residential neighborhoods and commercial/industrial areas. Local bus routes will often include collector streets.

### 40-1.01(03) Local Roads and Streets

All public roads and streets not classified as arterials or collectors are classified as local roads and streets. Local roads and streets are characterized by their many points of direct access to adjacent properties and their relatively minor value in accommodating mobility. Speeds and volumes are usually low and trip distances short. Through traffic is often deliberately discouraged.

### 40-1.01(04) Recreational Roads

Recreational roads, which are a subset of local roads, provide access to campgrounds, parks, boat launching ramps, picnic areas, and scenic and historic sites. They are typically designed to protect and enhance the existing aesthetic, ecological, environmental and cultural amenities that form the basis for distinguishing each recreational site or area. Because of their unique functional purpose, special geometric design criteria have been developed for recreational roads. These are presented in Chapter Fifty-one.

## 40-1.02 Urban Design Subcategories (by Type of Area)

The functional classification system is divided into urban and rural categories. However, in many cases an urban/rural designation is not sufficiently specific to determine the appropriate project design, especially in urban areas. Therefore, the design criteria for urban projects in Chapters Fifty-three through Fifty-six are further divided by the type of area where the project is located. This refinement to the highway design process will allow the designer to better tailor urban projects to the constraints of the surrounding environment.

Within an urbanized or urban area, the selection of design values will depend upon the design subcategory of the facility. Separate designs are appropriate for "suburban," "intermediate" and "urban" classifications. The following presents a description of the three subcategories:

1. Suburban. These areas are usually located at the fringes of urbanized or small urban areas. The predominant character of the surrounding environment is usually residential, but it may also include a considerable number of commercial establishments, especially strip development along a suburban arterial. There may also be a few industrial parks in suburban areas. On suburban roads and streets, drivers usually have a significant degree

of freedom but, nonetheless, they must also devote some of their attention to entering and exiting vehicles. Roadside development is characterized by low to moderate density. Pedestrian activity may or may not be a significant design factor. Right-of-way is often available for roadway improvements.

Local and collector streets in suburban areas are typically located in residential areas, but may also serve a commercial area. Posted speed limits typically range between 50 and 80 km/h. The majority of intersections will have stop or yield control, but there will be an occasional traffic signal. A typical suburban arterial will have strip commercial development and perhaps a few residential properties. Posted speed limits usually range between 60 and 90 km/h, and there will usually be a few signalized intersections along the arterial.

2. Intermediate. As its name implies, intermediate areas fall between suburban and built-up areas. The surrounding environment may be either residential, commercial or industrial or some combination of these. On roads and streets in intermediate areas, the extent of roadside development will have a significant impact on the selected speeds of drivers. The increasing frequency of intersections is also a major control on average travel speeds. Pedestrian activity has now become a significant design consideration, and sidewalks and cross walks at intersections are common. The available right-of-way will often restrict the practical extent of roadway improvements.

   Local and collector streets in intermediate areas typically have posted speed limits between 50 and 70 km/h. The frequency of signalized intersections has increased substantially when compared to suburban areas. An arterial in an intermediate area will often have intensive commercial development along its roadside. Posted speed limits range between 60 and 80 km/h. These arterials typically have several signalized intersections per mile.

3. Built-up. These areas normally refer to the central business district within an urbanized or small urban area. The roadside development has a high density and is often commercial. However, a substantial number of roads and streets in built-up areas pass through a high-density, residential environment (e.g., apartment complexes, row houses). Access to property is the primary function of the road network in built-up areas. Pedestrian considerations may be as important as vehicular considerations, especially at intersections. Right-of-way for roadway improvements is usually not available.

   Because of the high density of development in built-up areas, the distinction between the functional classes (local, collector or arterial) becomes less important when considering signalization and speeds. The primary distinction among the three functional classes is often the relative traffic volumes and, therefore, the number of lanes. As many as half

the intersections may be signalized; posted speed limits typically range between 40 and 60 km/h.

See Section 40-1.01 for definitions of the functional classifications (e.g., freeway).

## 40-1.03 Federal-Aid System

The Federal-aid system previously consisted of those routes within Indiana which were eligible for the categorical Federal highway funds. The Department, working with the local governments and in cooperation with FHWA, designated the eligible routes. The criteria were based on the relative importance of the highway route and the anticipated functional classification 5-10 years in the future. United States Code, Title 23, described the applicable Federal criteria for establishing the Federal-aid system.

The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 implemented a major realignment of the Federal-aid system. Traditionally, the system had been divided into Interstate, primary, secondary and urban Federal-aid systems. Separate categories of Federal funds were available for eligible Federal-aid projects on each system. The following sections briefly describe the Federal-aid system created by ISTEA.

### 40-1.03(01) National Highway System

The National Highway System (NHS) is a system of those highways determined to have the greatest national importance to transportation, commerce and defense in the United States. It consists of the Interstate highway system, logical additions to the Interstate system, selected other principal arterials, and other facilities which meet the requirements of one of the subsystems within the NHS. The National Highway System in Indiana has been revised recently to include designated Intermodal Connectors which serve major ports, airports, international border crossings, public transportation and transit facilities, interstate bus terminals and rail and intermodal transportation facilities. Two Strategic Highway Network (STRAHNET) facilities have been designated also. The NHS represents approximately 4%-5% of the total public road mileage in the United States. Specifically, the NHS includes the following subsystems (note that a specific highway route may be on more than one subsystem):

1. Interstate System. The current Interstate system of highways retains its separate identity within the NHS. There are also provisions to add mileage to the existing Interstate subsystem.

2. Other Principal Arterials. These are highways in rural and urban areas which provide access between an arterial and a major port, airport, public transportation facility or other intermodal transportation facility.

3. Strategic Highway Network. This is a network of highways which are important to the United States' strategic defense policy and which provide defense access, continuity and emergency capabilities for defense purposes.

4. Major Strategic Highway Network Connectors. These are highways which provide access between major military installations and highways which are part of the Strategic Highway Network.

5. Intermodal Connectors. These are highways connecting NHS routes to major ports, airports, international border crossings, public transportation and transit facilities, interstate bus terminals, and rail and other intermodal transportation facilities.

New NHS maps illustrating these routes and their locations are now available and accessible on the Department's web page. The web page address for these maps is: www.state.in.us/dot/TS/nhs.

The 1991 ISTEA mandated that each State highway agency, in cooperation with other jurisdictional agencies, develop and implement several management systems. These include management systems for pavements, bridges, traffic congestion, highway safety, public transportation facilities/equipment and intermodal transportation facilities/systems. Chapter Four discusses INDOT's development of highway management systems.

Local and military authorities should be consulted to verify the project traffic assignments (AADTs), truck volumes (% AADT Commercial) and types of trucks that use the facility to assure that the proper design vehicles are used for geometric design on the project.

**40-1.03(02) Surface Transportation Program**

The Surface Transportation Program (STP) is a new block grant type program that may be used by the States and localities for any roads (including NHS facilities) that are not functionally classified as local or rural minor collectors. These roads are now collectively referred to as Federal-aid roads. Bridge projects paid for with STP funds are not restricted to Federal-aid roads, but may be on any public road. Transit capital projects are also eligible under the STP program.

### 40-1.03(03) Bridge Replacement and Rehabilitation Program

The Bridge Replacement and Rehabilitation Program (BRRP) has retained its separate identity within the Federal-aid program. BRRP funds are eligible for work on any bridge on any public road regardless of its functional classification.

## 40-1.04 Jurisdictional System

The State of Indiana contains approximately 148,000 km of public roads as of 1990. The network has been divided into several jurisdictional systems based on the organization or agency responsible for highway and street improvements and for maintenance.

### 40-1.04(01) State Highway System

The State highway system consists of all highways under the jurisdiction of the Indiana Department of Transportation. This system contains all Interstate highways, the Indiana Toll Road, the majority of the facilities on the National Highway System, and other State and U.S. routes not on the NHS. The State highway system equals about 12%, or 18,267 km (in 1990), of all public roads and streets in Indiana. In general, these routes are the most important highways in the State, have the greatest traffic volumes and operate at the highest speeds.

### 40-1.04(02) County Road System

The county governments are responsible for all roads within their boundaries which are not on the State highway system and are not the responsibility of the incorporated cities within the county. There are 106,339 km (in 1990) of county-maintained roads in Indiana. In addition to the County road system, the counties are responsible for maintenance and improvements to any bridges on city roads and streets. INDOT is responsible for administering Federal funds which are available for highway improvements on eligible county routes. The construction of railroad or county road bridges over State or Interstate routes is the responsibility of INDOT. The maintenance of these county road bridges is the responsibility of INDOT. The maintenance of the railroad bridges is the responsibility of the railroad companies.

### 40-1.04(03) City Road and Street System

The city road and street system consists of all public roads within the corporate limits except those on the State highway system. There are 23,366 km (in 1990) of city-maintained roads and streets in Indiana. The extension of these routes outside the corporate limits, but still within an urbanized or small urban area, are the responsibility of the county. INDOT is responsible for administering Federal funds which are available for highway improvements on eligible city roads and streets.

### 40-1.04(04) DNR Recreational Roads

The Indiana Department of Natural Resources (IDNR) is responsible for maintaining roads within State public recreational areas. In some cases, INDOT will be responsible for the design and construction of these facilities in cooperation with IDNR.

## 40-1.05 National Truck Network

The Surface Transportation Assistance Act (STAA) of 1982 required that the U.S. Secretary of Transportation, in cooperation with the State highway agencies, designate a national network of highways which allow the passage of trucks of specified minimum dimensions and weight. The objective of the STAA is to promote uniformity throughout the nation for legal truck sizes and weights on a National Truck Network. The Truck Network includes all Interstate highways and significant portions of the former Federal-aid primary system (before the 1991 ISTEA) built to accommodate large-truck travel. In addition, the STAA requires that "reasonable access" be provided along other designated routes to the STAA commercial vehicles from the National Truck Network to terminals and to facilities for food, fuel, repair and rest and, for household goods carriers, to points of loading and unloading.

Under Indiana State statute, all principal arterials are available to commercial vehicles with the dimensions authorized by the STAA, subject to local restrictions. In addition, the State has enacted legislation that stipulates that all public roads are legally available to the STAA vehicles, subject to local restrictions. The geometric design criteria presented in the applicable chapters of Part V reflect the impact of the STAA vehicles on road design. For example, 3.6-m lane widths are required on all highways on the National Truck Network.

Figure 40-1B shows the National Truck Network in Indiana.

## *40-2.0 TRAFFIC VOLUME CONTROLS*

**40-2.01 Definitions**

1. Average Annual Daily Traffic (AADT). The total yearly volume in both directions of travel divided by the number of days in a year.

2. Average Daily Traffic (ADT). The calculation of average traffic volumes in both directions of travel in a time period greater than one day and less than one year and divided by the number of days in that time period. Although incorrect, ADT is often used interchangeably with AADT.

3. Capacity. The maximum number of vehicles which can reasonably be expected to traverse a point or uniform section of a road during a given time period under prevailing roadway, traffic and control conditions. The time period most often used for analysis is 15 minutes. "Capacity" corresponds to Level of Service E.

4. Delay. The primary performance measure on interrupted flow facilities, especially at signalized intersections. For this element, average stopped-time delay is measured, which is expressed in seconds per vehicle.

5. Density. The number of vehicles occupying a given length of lane, averaged over time. It is usually expressed as vehicles per kilometer per lane.

6. Design Hourly Volume (DHV). The 1-hour volume in both directions of travel in the design year selected for determining the highway design. The DHV is often the 30th highest hourly volume during the design year. Note that, for capacity analyses, the DHV is typically converted to an hourly flow rate based on the maximum 15-minute flow rate during the DHV.

7. Service Flow Rate. The maximum hourly vehicular volume which can pass through a highway element at the selected level of service.

8. Directional Design Hourly Volume (DDHV). The 1-hour volume in one direction of travel during the DHV in the selected design year.

9. Directional Distribution (D). The division, by percent, of the traffic in each direction of travel during the DHV, ADT and/or AADT.

10. Level of Service (LOS). A qualitative concept which has been developed to characterize acceptable degrees of congestion as perceived by motorists. In the *Highway Capacity Manual*, the qualitative descriptions of each level of service (A to F) have been converted into quantitative measures for the capacity analysis for each highway element, including:

a. freeway mainline;
b. freeway mainline/ramp junctions;
c. freeway weaving areas;
d. interchange ramps;
e. 2-lane, 2-way rural highways;
f. multi-lane rural highways;
g. signalized intersections;
h. unsignalized intersections; and
i. urban and suburban arterials.

Chapters Fifty-three through Fifty-six present guidelines for selecting the level of service for capacity analyses in road design.

11. Peak-Hour Factor (PHF). A ratio of the volume occurring during the peak hour to the maximum rate of flow during a given time period within the peak hour (typically, 15 minutes).

12. Percent Trucks (T). A factor which reflects the percentage of heavy vehicles (trucks, buses and recreational vehicles) in the traffic stream during the DHV, ADT and/or AADT. For geometric design and capacity analyses, trucks are defined as vehicles with six or more tires. Data on trucks are compiled and reported by the Program Development Division's Traffic Statistics Unit.

13. Rate of Flow. The equivalent hourly rate at which vehicles pass over a given point or section of a lane or roadway during a given time interval less than one hour (typically, 15 minutes).

## 40-2.02 Design Year Selection

### 40-2.02(01) Roadway Design

A highway should be designed to accommodate the traffic volumes expected to occur within the life of the facility under reasonable maintenance. This involves projecting the traffic conditions for a selected future year. Recommended design years are presented in Figure 40-2A, Recommended Design Year Selection (Traffic Volumes for Road Design). The design year is measured from the expected letting date for construction. Future traffic volumes on State highways are provided by the Program Development Division's Traffic Statistics Unit.

**40-2.02(02) Other Highway Elements**

The following presents the recommended criteria for consideration of a design year for highway elements other than road design:

1. Bridges/Underpasses. The structural life of a bridge may be 50 years or more. For new bridges (including bridge replacements), the initial clear roadway width of the bridge or underpass will be based on the 20-year traffic volume projection beyond the original projected letting date for construction.

   Bridge rehabilitation projects are those for which a significant amount of the existing substructure or superstructure will remain in place. For bridge rehabilitation projects which include significant improvements to all or part of the superstructure (including full bridge deck replacement), the clear roadway width will be based on the 20-year traffic volume projection beyond the original projected letting date for construction. Those projects which include bridge deck overlays may be based on the 10-year projected traffic volume. For bridge rehabilitation projects which only include improvements to the substructure, the bridge will be evaluated as an existing bridge to remain in place. See Chapters Fifty-three through Fifty-six for specific criteria.

2. Right-of-Way/Grading. The designer should consider potential right-of-way needs for the anticipated long-term corridor growth for a year considerably beyond that used for roadway design. No specific design year is recommended; however, when selecting an initial median width on a divided highway, for example, the designer should evaluate the potential need for future expansion of the facility to add through travel lanes. Other examples include potential future interchanges and potential dualization of a 2-lane, 2-way facility.

3. Drainage Design. Drainage appurtenances are designed to accommodate a flow rate based on a specific design year (or frequency of occurrence). The selected design year or frequency will be based on the functional class of the facility and the specific drainage appurtenance (e.g., culvert). Chapter Twenty-nine presents the Department's criteria for selecting a design year for drainage.

4. Pavement Design. The pavement structure is designed to withstand the vehicular loads it will sustain during the design analysis period without falling below a selected terminal pavement serviceability. Chapter Fifty-two presents the Department's criteria for selecting a design year for pavement design.

## 40-2.03 Design Hourly Volume Selection

For most geometric design elements which are impacted by traffic volumes, the peaking characteristics are most significant. The highway facility should be able to accommodate the design hourly volume (adjusted for the peak-hour factor) at the selected level of service. This design hourly volume (DHV) will affect many design elements including the number of travel lanes, lane and shoulder widths and intersection geometrics. The designer should also analyze the proposed design using the a.m. and p.m. DHVs separately. This could have an impact on the geometric design of the highway.

The 30th highest hourly volume in the selected design year will typically be used to determine the DHV for design purposes.

## 40-2.04 Capacity Analyses

### 40-2.04(01) Objective

The highway mainline, intersection or interchange should be designed to accommodate the selected design hourly volume (DHV) at the selected level of service (LOS). This may involve adjusting the various highway factors which affect capacity until a design is found that will accommodate the DHV. The detailed calculations, factors and methodologies are presented in the *Highway Capacity Manual* (HCM). Chapter Forty-one presents additional information the Department has adopted for the use of the HCM. In reality, the service flow rate of the facility is calculated. Capacity assumes a LOS E; service flow rate is the maximum volume of traffic that a proposed highway of given geometrics is able to serve without the degree of congestion falling below a preselected LOS. This is almost always higher than LOS E.

The HCM has established measures of effectiveness for the level-of-service definition for each highway element on various types of highway facilities. These are presented in Figure 40-2B, Measures of Effectiveness for Level of Service. For each measure, the HCM will provide the analytical tools to calculate the numerical value.

The following presents the simplified procedure for conducting a capacity analysis for the highway mainline.

1. Select the design year (Section 40-2.02).

2. Determine the DHV (Section 40-2.03).

3. Select the level of service (Chapters Fifty-three through Fifty-six).

4. Document the proposed highway geometric design (lane width, clearance to obstructions, length of weaving section, number and width of approach lanes at intersections, etc.).

5. Using the HCM, analyze the capacity of the highway element for the proposed design:

    a. determine the maximum flow rate under ideal conditions;

    b. adjust the maximum flow rate for prevailing roadway, traffic and control conditions; and

    c. calculate the service flow rate for the selected level of service.

6. Compare the calculated service flow rate to the DHV. If the DHV is less than or equal to the service flow rate, the proposed design will meet the objectives of the capacity analysis. If the DHV exceeds the service flow rate, the proposed design will be inadequate. The designer should either adjust the highway design or should adjust one of the capacity elements (e.g., the selected design year or the level-of-service goal).

### 40-2.04(02) Responsibility

For projects designed by either INDOT or consultants on State highways, the Environment, Planning and Engineering Division or its consultant is responsible for performing all capacity analyses required by the project.

For consultant-designed projects on non-State highways, the capacity analysis may be performed by either the local jurisdiction or the consultant.

## *40-3.0 SPEED*

### 40-3.01 Definitions

1. Design Speed. Design speed is the maximum safe speed that can be maintained over a specified section of highway when conditions are so favorable that the design features of the highway govern. A design speed is selected for each project which will establish criteria for several design elements including horizontal and vertical curvature, superelevation and sight distance. Section 40-3.02 discusses the selection of design speed in general. Chapter Fifty-three presents specific design speed criteria for new

construction and reconstruction projects. Chapters Fifty-four through Fifty-six provide the design speed criteria for projects on existing highways.

2. Low Speed. For geometric design purposes, low speed is defined as 70 km/h or less.

3. High Speed. For geometric design purposes, high speed is defined as 80 km/h or greater.

4. Average Running Speed. Running speed is the average speed of a vehicle over a specified section of highway. It is equal to the distance traveled divided by the running time (the time the vehicle is in motion). The average running speed is the distance summation for all vehicles divided by the running time summation for all vehicles.

5. Average Travel Speed. Average travel speed is the distance summation for all vehicles divided by the total time summation for all vehicles. (Note: Average running speed only includes the time the vehicle is in motion. Therefore, on uninterrupted flow facilities which are not congested, average running speed and average travel speed are equal.)

6. Operating Speed. Operating speed, as defined by AASHTO, is the highest overall speed at which a driver can safely travel a given highway under favorable weather conditions and prevailing traffic conditions while at no time exceeding the design speed. Therefore, for low-volume conditions, operating speed equals design speed. The designer should note that this term has little or no usage in geometric design.

7. 85th-Percentile Speed. The 85th-percentile speed is the speed below which 85 percent of vehicles travel on a given highway. The most common application of the value is its use as one of the factors, and usually the most important factor, for determining the posted, regulatory speed limit of a highway section. In most cases, field measurements for the 85th-percentile speed will be conducted during off-peak hours when drivers are free to select their desired speed.

8. Posted Speed Limit. If needed, the INDOT district offices conduct the traffic engineering studies on the State highway system to select a posted speed limit. When a study is performed, on either the State or local system, the posted speed limit is based on several factors:

    a. the 85th-percentile speed;

    b. the design speed used during project design;

    c. road surface characteristics, shoulder condition, grade, alignment and sight distance;

d. functional classification and type of area;

e. type and density of roadside development;

f. the accident experience during the previous 12 months; and

g. parking practices and pedestrian activity.

On new construction/reconstruction projects, the posted speed limit will typically be equal to the design speed used in design, if this does not exceed the legal limit. A traffic engineering study may be conducted for various reasons to assist in the determination of the posted speed limit. This procedure applies to both State and non-State facilities.

9. Legal Speed Limit. Legal speed limits are those set by the Indiana Statutes which apply, in general, to those public roads which do not have a posted speed limit. Section 40-3.02 presents specific legal speed limits adopted by the State of Indiana. Advisory speed signs are not regulatory signs; hence, they are meaningless for determining the posted speed limit of a road.

## 40-3.02 Design Speed Selection

### 40-3.02(01) Geometric Design Considerations

From a geometric design perspective, the selected design speed is based on the following road design elements:

1. Functional Classification. In general, the more important facilities are designed with a higher design speed than the less important facilities.

2. Urban/Rural. Design speeds in rural areas are generally higher than those in urban areas. This is consistent with the typically fewer constraints in rural areas (e.g., less development).

3. Terrain. The flatter the terrain, the higher the selected design speed will be. This is consistent with the typically higher construction costs as the terrain becomes more rugged.

4. Traffic Volumes. For some facilities, design speed varies by traffic volumes; i.e., as traffic volumes increase, higher design speeds are used. For example, design speeds on rural collector roads vary according to traffic volumes.

5. Project Scope of Work. In general, higher design speeds are more applicable to new construction/reconstruction projects than to 3R projects.

For geometric design application, the relationship between these road design elements and the selected design speed reflects general cost-effective considerations. For example, the higher the traffic volumes, the more benefits to the traveling public from a higher design speed.

**40-3.02(02) Regulatory Speed vs. Design Speed**

All public roads in Indiana are controlled by regulatory speed limits, either through posted speed limit signs or with legal speed limits contained in the Indiana statutes (see Section 40-3.02(03)). The following statements summarize the relationship between the project design speed and the regulatory speed limit:

1. General. The design speed should equal or exceed the anticipated posted speed limit after construction or the State legal speed limit on non-posted highways.

2. Non-Posted Facilities (Rural). In rural areas, the maximum legal speed limit is 89 km/h on non-posted facilities. Projects on these facilities must be designed for 90 km/h, or a traffic engineering study must be conducted to determine if a lower design speed is appropriate. If the project is designed for less than 90 km/h, the road must be posted at the selected design speed between logical termini.

3. Non-Posted Facilities (Urban). In urban areas, the maximum legal speed limit, and corresponding minimum design speeds, are as follows on non-posted facilities:

    a. on State highways, 48 km/h (50 km/h minimum design speed); and
    b. on non-State highways, 89 km/h (day) and 80 km/h (night) (90 km/h minimum design speed).

    As in rural areas, the minimum design speed must meet these criteria, unless a traffic engineering study indicates otherwise.

To avoid a potential conflict, the Pre-Engineering and Environment Division should, early in project development, coordinate the design speed selection with the District Office to assist in establishing the anticipated posted speed limit of the completed facility. If the proposed design

speed from the Geometric Design Tables is less than the established posted speed limit, one of the following approaches must be selected:

1. increase the project design speed to equal or exceed the established or anticipated posted speed limit; or

2. seek a design exception for the individual geometric design element(s) (e.g., a horizontal curve) which do not meet the established speed limit.

**40-3.02(03) Legal Speed Limits**

This Section summarizes the legal speed limits established by the Indiana Statutes. Figure 40-3A, Legal Speed Limits, presents the legal limits for rural and urban areas and for State and non-State facilities.

1. Maximum Speed Limits. IC9-21-5-2 and IC9-21-5-6 of the Statutes sets maximum speed limits which apply to vehicular speeds on all public roads in the State. Note that these maximum limits do not establish upper limits for geometric design speeds. The speed limits are established by statute in english units, so are thus shown in english (metric) as follows:

    a. 30 mph (48 km/h) on State highways in an urban district;*

    b. 65 mph (105 km/h) on Interstates, except within urbanized areas;

    c. 60 mph (97 km/h) for a vehicle other than a bus having a gross weight greater than 11,800 kg when operating on the Interstate system outside of an urbanized area;

    d. 15 mph (24 km/h ) in alleys, with an absolute maximum of 30 mph (48 km/h);*

    e. 55 mph (89 km/h) on all rural facilities; and

    f. 30 mph (48 km/h) on non-State highways in urban districts, with an absolute maximum of 55 mph (89 km/h) daytime, and 50 mph (80 km/h) nighttime.*

    * Requires an engineering and traffic investigation study to establish a maximum speed limit that is different from the value shown.

2. Absolute Minimum Speed Limits (Non-State Facilities). IC9-21-5-6 of the Statutes sets minimum speed limits which apply to non-State roads and streets which are not posted with a regulatory speed limit sign. The speed limits for these facilities are also established by statute in english units, so are thus shown in english (metric) as follows:

   a. Alleys. The minimum speed limit is 5 mph (8 km/h).**

   b. Urban Districts. Except as noted in Items 1d and 1e above, the minimum speed limit is 20 mph (32 km/h).**

   c. Rural Areas. Outside of urban districts, the minimum speed limit is 30 mph (48 km/h), except as noted in Item 1d above.**

   d. School Zones. A local authority may establish speed limits within school zones on State highways, if the following conditions are met:

      (1) The limit is not less than 20 mph (32 km/h).

      (2) The limit is imposed only in the immediate vicinity of the school.

      (3) Children are present.

      (4) The speed zone is properly signed.

      (5) The Indiana Department of Transportation has been notified by certified mail of the limit imposed.

   e. Parks/Playgrounds. A local authority may decrease the speed limit on an urban street to not less than 15 mph (24 km/h), if the following conditions exist:

      (1) The street is located within a park or playground established under IC 36-10.

      (2) The: boards established under IC 36-10-3 or IC 36-10-4, or the park authority established under IC 36-10-5 requests the local authority to decrease the limit.

      (3) The speed zone is properly signed.

** Requires an engineering and traffic investigation study to establish a speed limit that is below the maximum. However, the lower limit can not be less than the minimum value shown.

## *40-4.0 VEHICULAR CHARACTERISTICS*

The physical and operational characteristics of vehicles using the highway are important controls in geometric design. These will vary according to the type of vehicle being considered. When a highway facility or intersection is under design, the largest design vehicle likely to use that facility with considerable frequency should be used to determine the selected design values. See Chapter Forty-six for the design vehicle selection at intersections.

Figure 40-4A, Design Vehicle Dimensions, presents basic information on dimensions for the standard design vehicles. Figure 40-4B, Basic Dimensions of Design Vehicle (Combination Truck A), and Figure 40-4C, Basic Dimensions of Design Vehicle (Combination Truck B), present illustrations for two combination trucks for application of the basic dimensions.

## *40-5.0 ACCESS CONTROL (Definitions)*

Access control is defined as the condition where the public authority fully or partially controls the right of abutting owners to have access to and from the public highway. The functional classification of a highway is partially determined by the degree of access it allows. Access control may be exercised by statute, zoning, right-of-way purchases, driveway controls and permits, turning and parking regulations or geometric design (e.g., grade separations and frontage roads).

The following provides definitions for the three basic types of access control:

1. Full Control. Full control of access is achieved by giving priority to through traffic by providing access only at interchanges with selected public roads. No at-grade crossings or private driveway connections are allowed. Freeway is the common term used for this type of highway. Full control of access maximizes the capacity, safety and vehicular speeds on the freeway.

2. Partial Control. Partial control of access is an intermediate level between full control and no control. Priority is given to through traffic, but a few at-grade intersections and private driveway connections may be allowed. The proper selection and spacing of at-grade intersections and service connections will provide a balance between the mobility, safety and access service of the highway. This type of facility is generally termed an expressway.

3. None. The use of the term “none” is actually a misnomer. All highways warrant some degree of access control by permit or by design. If access points to other public roads and driveways are properly spaced and designed, the adverse effects on highway capacity

and safety will be minimized. These points should be located where they can best suit the traffic and land-use characteristics of the highway under design. Their design should enable vehicles to enter and exit safely with a minimum of interference to through traffic. Access control is exercised by the Department on the State highway system and by local jurisdiction on other facilities to determine where private interests may have access to and from the public road system.

The designer should reference the following for more information on access control regulations and design guidelines in Indiana:

1. Indiana Local Technical Assistance Program (LTAP) *Access Control for Local Roads and Streets in Small Cities and Rural Areas*,

2. INDOT *Right-of-Way Engineering Procedures Manual*,

3. INDOT *Standard Drawings*,

4. INDOT *Driveway Permit Handbook*, and

5. *Indiana Design Manual*:

    a. Section 46-8.0 "Median Openings,"
    b. Section 46-11.0 "Driveway Design,"
    c. Section 48-6.06 "Access Control" (for interchanges),
    d. Section 48-1.03 "New/Revised Interchanges on the Interstate System," and
    e. Chapter Eighty-six "Access Control."

## *40-6.0 PROJECT SCOPE OF WORK*

The project scope of work will reflect the basic intent of the highway project and will determine the overall level of highway improvement. This decision will determine which criteria in this Part of the *Indiana Design Manual* will apply to the geometric design of the project.

## 40-6.01 Definitions

### 40-6.01(01) New Construction

New construction is defined as horizontal and vertical alignment on new location. In addition, any intersection or interchange which falls within the project limits of a new highway mainline

or is relocated to a new point of intersection is considered new construction. Chapters Forty through Fifty-three present the Department's criteria for new construction.

### 40-6.01(02) Complete Reconstruction (Freeways)

Complete reconstruction of an existing freeway is defined as replacement of the existing facility. Complete reconstruction results in significant improvements to the freeway's level of service, operational efficiency and safety. Because of the significant level of work, Chapters Forty through Fifty-three will apply to the design of a complete reconstruction project.

### 40-6.01(03) Partial Reconstruction (4R) (Freeways)

Partial reconstruction (4R) of an existing freeway is defined as work which includes one or more of the following improvements:

1. a significant portion (over 30%) of the travelway pavement area must be removed and replaced, (pavement rubblization with an overlay is considered to be one form of pavement removal and replacement)

2. a thick (over 150 mm) concrete overlay or a thick (200 mm or greater) bituminous overlay as measured at the point of thickest overlay over the existing travelway, is required,

3. the facility cannot adequately accommodate the current or projected (10 year) traffic demand and additional lanes are necessary,

4. major revisions are necessary to the existing horizontal and vertical alignment requiring that over 30% of the travelway pavement must be replaced,
5. total bridge or bridge deck replacement is required,

6. bridge deck widening is necessary due to added travel lanes on the approach, and/or

7. interchange upgrading is required to meet current and projected (20-year) traffic demands.

Partial 4R freeway projects are designed according to the criteria in Chapter Fifty-four.

**40-6.01(04) Reconstruction (4R) (Non-Freeways)**

Reconstruction of an existing highway mainline (4R projects) will typically include the addition of travel lanes and/or major revisions to the existing horizontal and vertical alignment and/or reconstruction of a significant portion of the existing pavement structure; however, the highway will remain essentially within the existing highway corridor. These projects may require right-of-way acquisitions. A 4R (reconstruction) project is typically undertaken because one or more of the following conditions exist along the highway:

1. A significant portion (over 30%) of the pavement area in the traveled way must be removed and replaced, or a thick (over 150-mm) concrete overlay must be constructed, or a thick (200 mm or greater) bituminous overlay as measured at the point of thickest overlay the existing travelway, is placed.

2. The facility cannot adequately accommodate its current or projected (10-year) traffic demand and additional lanes are necessary.

3. Major revisions are necessary to the existing horizontal and vertical alignment requiring more than 30% of the traveled way to be replaced.

4. Bridge replacement or total deck replacement is necessary.

5. Bridge deck widening is necessary because of added travel lanes on the project.

6. Major interchange upgrading is necessary to meet current and projected (20-year) traffic demands at an acceptable level of service. However, an analysis may determine that interim improvements are cost effective.

7. Work planned on adjoining sections of the highway involves reconstruction for an appreciable length of the highway requiring reconstruction on the project to achieve roadway design consistency along the route between logical termini.

The final decision on selecting a 4R scope of work for the project will be made based on the Department's long-range plans for upgrading the State's highway system. See Section 40-6.02 for more information.

Because of the significant level of work for reconstruction, the design of the project will be determined by the criteria for new construction. Therefore, Chapters Forty through Fifty-three will apply to reconstruction (4R) projects.

Added travel lanes projects, where the project consists of increasing the number of travel lanes, should be classified as 4R projects.

**40-6.01(05) 3R Projects (Freeways)**

3R projects (resurfacing, restoration and/or rehabilitation) on existing freeways are primarily intended to extend the service life of the existing facility and to enhance highway safety. In addition, 3R projects should make cost-effective improvements to the existing geometrics, where practical. Right-of-way acquisitions are rarely needed. Typical improvements for 3R freeway projects may include any number of the following:

1. pavement resurfacing;

2. full-depth pavement reconstruction, if the reconstructed pavement area is 30% or less of the traveled way;

3. widening existing travel lanes or shoulders;

4. upgrading the structural strength of shoulders;

5. improving the superelevation of existing horizontal curves;

6. adding auxiliary lanes;

7. improving roadway delineation;

8. upgrading roadside safety;

9. increasing the length of acceleration and deceleration lanes at an interchange;

10. widening an existing bridge as part of a bridge reconstruction project;

11. upgrading or replacing bridge rails;

12. overlaying bridge decks;

13. preservation of bridge substructures;

14. improving roadside drainage;

15. widening an existing ramp;

16. flattening a horizontal or vertical curve; and/or

17. increasing the vertical clearance at underpasses.

Chapter Fifty-four presents the criteria for the design of 3R freeway projects.

**40-6.01(06) 3R Projects (Non-Freeways)**

3R projects (rehabilitation, restoration and/or resurfacing) on existing non-freeways are primarily intended to extend the service life of the existing facility and to enhance highway safety. In addition, 3R projects should make cost-effective improvements to the existing geometrics, where practical. 3R work on the mainline or at an intersection is typically work on the existing alignment. Minimal right-of-way acquisition is often required. Typical improvements for 3R non-freeway projects may include any combination of the following:

1. pavement resurfacing or rehabilitation and/or a limited amount of pavement reconstruction (30% or less of the traveled way area);

2. bridge rehabilitation or replacement;

3. lane and shoulder widening;

4. upgrading the structural strength of shoulders;

5. flattening an occasional horizontal or vertical curve;

6. adjustments to the roadside clear zone;

7. flattening side slopes;

8. converting an existing median to a 2-way left-turn (TWLT) lane;

9. adding a truck-climbing lane;

10. converting an uncurbed urban street into a curbed street;
11. revising the location, spacing or design of existing driveways along the mainline;

12. adding or removing parking lanes;

13. bridge widening and associated substructure work to accommodate the widening;

14. bridge rail upgrading or replacement;

15. bridge deck overlays;

16. work to preserve the bridge substructure;

17. adding sidewalks;

18. relocating utility poles;

19. upgrading guardrail and other safety appurtenances to meet current criteria;

20. other geometric and/or safety improvements to existing bridges within the project limits;

21. drainage improvements;

22. increasing vertical clearances at underpasses;

23. intersection improvements (e.g., adding turn lanes, flattening turning radii, channelization, corner sight distance improvements, etc.);

24. adding new or upgrading traffic signals; and/or

25. other spot improvements.

Specifically related to the level of pavement improvement, the following definitions apply:

1. Resurfacing. Resurfacing consists of the placement of additional surface material over the existing restored or rehabilitated roadway or structure to improve serviceability or to provide additional strength.

2. Restoration/Rehabilitation. Restoration/rehabilitation is defined as work required to return the existing pavement to a condition of adequate structural support or to a condition adequate for the placement of an additional stage of construction. This may include milling the existing pavement.

Chapter Fifty-five presents the criteria for the design of 3R non-freeway projects.

**40-6.01(07) Partial 3R Projects**

Partial 3R projects are intended to extend the service life of the pavement and, where practical, to enhance highway safety. Geometric design improvements are usually included to correct obvious deficiencies on the existing highway. Right-of-way acquisition is rarely involved. Improvements for partial 3R projects may include any of the following:

1. pavement resurfacing,
2. lane and shoulder widening,
3. adjustments to the roadside clear zone,
4. relocating utility poles,
5. upgrading guardrail and other safety appurtenances to meet current criteria,
6. correcting high-accident locations,
7. drainage improvements, and/or
8. improving superelevation to extent practical.

Chapter Fifty-six presents the criteria for the design of partial 3R projects. The only partial 3R treatment permitted on NHS routes is preventative maintenance. All types of partial 3R treatments are permitted on non-NHS routes. Chapter Fifty-Two presents pavement design criteria for all types of projects.

**40-6.01(08) High-Accident Location Improvements (Non-Freeways)**

1. Non-NHS Routes. These projects are intended to make improvements to correct a safety problem at locations that are identified through the FHWA-approved INDOT Safety Improvement Program process, which applies to both State and local facilities. They are not intended to provide a general upgrading of the highway, as are projects categorized as new construction/reconstruction or 3R. The *Design Manual* presents no specific design criteria for this type of improvement. The objective is to rapidly correct an identified accident hazard using the highest level of design criteria as practical at the site considering any existing site limitations (e.g., right-of-way restrictions).

2. NHS Routes. High accident location improvements (on NHS routes) must follow the appropriate criteria or obtain a design exception(s). These are also identified through the FHWA approved INDOT safety improvement program, however, the design criteria to be used are those for new construction/reconstruction or 3R based on the criteria in subsection 40-6.02(01).

### 40-6.01(09) Traffic Control Device Projects

Traffic control device projects are programmed specifically to install, replace or remove signs, pavement markings, traffic signals, highway lighting, etc. No other work is typically included, except that traffic signal projects will include handicapped curb ramps at the involved intersections. Part VII "Traffic Design" presents the criteria for the installation of traffic control devices on both freeways and non-freeways.

## 40-6.02 Application

### 40-6.02(01) National Highway System (NHS) Projects

For long-range transportation planning purposes, INDOT has evaluated the State highway system to determine which routes warrant reconstruction (or 4R) and which routes warrant a 3R-type improvement. Figure 40-6A presents a map of the Indiana State highway system to indicate 3R and 4R routes within the State. The project scope of work definitions in Section 40-6.01 will apply to all projects on the NHS. The following will apply to the use of Figure 40-6A for those 3R and 4R routes on the NHS:

1. General. In general, two major factors will determine if the project should be classified as 3R or 4R:

    a. If 70% or more of the existing pavement area of the traveled way can be retained and resurfaced, the project may be classified as 3R. If not, the project is typically a 4R project.

    b. An assessment of the level of service (LOS) for the 10-year traffic volume projection can determine if the project is 3R or 4R, based upon the expected service life of the pavement.

    Other factors should also be considered when making the project scope of work determination (e.g., accident rates).

2. Freeways. Freeway projects will be classified as new construction, complete reconstruction, partial reconstruction or 3R. Refer to Section 40-6.01 for definitions.

3. 4R Non-Freeway Routes. The Preliminary Engineering Studies Section or the local jurisdictional agency will determine the level of service (LOS) for the 10-year traffic volume projections based on the discussion in Section 40-2.0. If this is LOS D or better,

then it will be acceptable to design the project using the 3R geometric design criteria in Chapter Fifty-five. If the projected LOS will not meet LOS D, the facility will typically be designed according to the criteria for new construction/reconstruction. All bridge replacements, bridge deck replacements and bridge widenings should be designed to meet 4R criteria.

4. 3R Non-Freeway Routes. The project will typically be designed according to the 3R geometric design criteria in Chapter Fifty-five. However, consideration could be given to using the 4R criteria.

5. 3R Projects. In all cases where the 3R project scope of work is selected, costly items (e.g., bridge reconstruction/replacement, alignment corrections), which have a long service life and can be incorporated into a future 4R project, should desirably be constructed to meet 4R design criteria as part of the 3R project.

6. Combination Projects. Where a project will include both 3R and 4R work, the overall project scope of work classification should be based on the predominant type of work. For example, a 10-km resurfacing project which includes the replacement of one of the mainline bridges (to 4R criteria) would generally be classified as a 3R project, unless the bridge is considered to be a major structure and its replacement cost is equal to or greater than that of the 3R roadway work.

Design Manual standards must be used at all NHS projects regardless of the funding source even if 100% state and/or private funds are used; however, values shown in the current AASHTO *Geometric Design of Highways and Streets* publication may be used as minimum values if they are lower than similar values in this Manual where restricted conditions warrant.

**40-6.02(02) Non-NHS Projects**

The project scope of work definitions in Sections 40-6.01 and 40-6.02(01) and Figure 40-6A, 3R/4R Systems, are intended only as general guidance on non-NHS projects. The decision on classifying a project that is not on the NHS should desirably be made based on the future plans of the jurisdictional highway agency for the entire road between logical termini for the foreseeable future (20 years). All future plans for a road must consider current and projected traffic volumes, anticipated land use and accident experience. The following presents several examples of applying this concept to non-NHS projects:

1. Example One. Approximately 60% of the pavement on a 10-km section of a county road will be replaced. The remainder of the pavement is in reasonably good condition and only requires milling and resurfacing. The 10-km section is part of a 50-km county road

which is the main highway between two small towns. The existing road has a LOS A, and it is anticipated to provide a LOS B based on 20-year projected traffic volumes. There is no adverse accident experience for the last three years. Based on this information, a highway agency could decide to designate the 3R classification and construct the road to 3R design criteria. This is acceptable even though more than 30% of the pavement is being completely replaced.

2. Example Two. Approximately 40% of the pavement on a 10-km section of county road will be replaced. The remainder of the segment will be resurfaced. This segment of road is part of a 40-km county road which connects two small towns. This county road is located approximately 30 km from a major metropolitan area. It is anticipated that, within the next 20 years, there will be considerable residential and commercial development adjacent to this stretch of county road because of its proximity to the rapidly expanding metropolitan area. The current LOS is B, but projected traffic volumes indicate that the LOS will drop to D in 10 years and to F in 20 years. In this case, the highway agency has two options. They could decide to design the project to 3R criteria for the present and, then, undertake a 4R project in 10 years when the pavement will likely be in need of major work. Their second option would be to construct the project to 4R criteria now to meet future traffic demands.

3. Example Three. A 10-km section of highway, which is located on INDOT's 3R highway system, requires complete pavement replacement because of poor drainage. The INDOT Central Office has rechecked the status of this highway with the District Office and verified that there are no plans for work on the remainder of this route in the future (20 years) except for 3R-type work. The current LOS is B, and it is anticipated to remain at B for the next 20 years. There is no adverse accident experience and no anticipated major land development along the route. INDOT could decide in this case to only construct the project to 3R design criteria, even though all of the pavement is being replaced.

4. Example Four. A 60-m long bridge on the State's 3R system requires complete replacement. In addition, there are sharp horizontal curves on each end of the bridge where numerous accidents have occurred during the last three years. It has been decided to correct the poor alignment on the bridge approaches and to construct the approaches and bridge on a new location. The total length of the project is 2.5 km. INDOT's Central Office has discussed the status of this road with the District Office and both agreed that it should remain on the 3R system. The current LOS is B, and it is estimated that the LOS will be C in 20 years. There are no plans except to perform 3R-type work to the remainder of the road for the future (20 years). In this case, INDOT could decide to construct the entire project to 3R design criteria.

5. Example Five. A 10-km segment of a route on INDOT's 3R system requires replacing 20% of the pavement and resurfacing the remaining 80%. The current LOS is D and will deteriorate to E in 5 years. There is rapid residential, commercial and industrial development in the area. Both the INDOT Central and District Offices agree that the entire route was properly classified as a 3R route. However, this one 10-km segment is an exception because rapid growth adjacent to this 10-km segment is expected to occur. The appropriate solution in this case would be to upgrade the facility to accommodate any anticipated traffic demand for the next 20 years and to design the project to 4R design criteria.

**40-6.02(03) Procedures**

For INDOT projects, the project scope of work is selected based on the following procedure:

1. The district office initially identifies the project scope.

2. The project is programmed based on the project scope determined by the d-istrict.

3. The Environment, Planning and Engineering Division will make the final decision on the scope of work for the project. However, on all NHS projects which have an estimated construction cost exceeding $1 million, FHWA will meet with representatives of the Environment, Planning and Engineering Division to cooperatively agree on the project classification and whether it should not be exempt from FHWA oversight on the project. This will occur as early in the project scoping process as possible so that FHWA can have input on those projects which are subject to their oversight. The meeting normally will be held as soon as an initial concept for the project design has been developed. The results, including classification and oversight determination, will be documented in the Engineer's Report. The cover of the report will indicate whether the project is exempt or not exempt from FHWA oversight.

4. The Design Division, during project design, may re-evaluate the project scope and request the Environment, Planning and Engineering Division to modify the scope of work.

For Federal-aid projects not on the State highway system, the project scope of work determination will be based on the future plans of the local agency for improvements to its local road or street system. The philosophy presented in Section 55-2.01(02) Item 2, on 4R non-freeway State routes should also be applied to local projects. The local agency must submit a letter to the INDOT Program Development Division to document the local agency's plans on that facility in the foreseeable future.

If the project is on the NHS and the estimated construction cost exceeds $1 million, then the Program Development Division will schedule a meeting with the local agency and the FHWA to agree upon a project classification (3R or 4R). This meeting should occur early in the scoping process so that FHWA can have input on those projects that are subject to their oversight.

### *40-7.0 FHWA INVOLVEMENT*

The 1991 *Intermodal Surface Transportation Efficiency Act* (ISTEA), and the Transportation Act of 1998, in addition to a realignment of the Federal-aid system, revised the role of the Federal Highway Administration on individual projects. The Transportation Efficiency Act for the 21st Century (TEA-21) of 1998, further revised the role of the FHWA on individual projects.

1. Highway System. FHWA involvement is only on Interstate projects on the National Highway System (NHS).

2. Project Scope of Work. FHWA involvement is only on new Interstate construction/ reconstruction projects.

3. Project Cost. FHWA involvement is only on Interstate projects with an estimated construction cost exceeding $1 million.

When a project is exempt, FHWA will not be involved with the normal day-to-day project activities, including field reviews, design approval, public hearing certification, design exceptions, PS&E submittal, etc. However, it is understood that all Federally funded projects will conform to the appropriate criteria in this *Manual*, as well as the INDOT *Standard Specifications* and *Standard Drawings*, regardless of FHWA review.

The oversight agreement indicates that the FHWA will normally only provide oversight and approval on Interstate New Construction/Reconstruction (4R) projects and Partial Reconstruction (4R) projects with a construction cost greater than $1 million.

The FHWA is not precluded from reviewing or investigating any phase of the federal-aid program including control documents or any federal-aid projects, especially those that contain unique features or those with unusual circumstances such as projects with special structure designs, experimental features, warranty work, Intelligent Transportation Systems (ITS) features, Design-Build projects, etc., which would make it desirable to have FHWA oversight. The oversight determination for these special features projects will be made at the meeting discussed in Section 40-6.02(03), Item 3. INDOT may request FHWA oversight on any federal-aid project.

## *40-8.0 ADHERENCE TO DESIGN CRITERIA*

Part V of the *Indiana Design Manual* presents literally thousands of pieces of information on geometric design for application on individual projects. In general, the designer is responsible for making every reasonable effort to meet these criteria in the project design. However, this will not always be practical. This Section discusses the Department's procedures for identifying, justifying and processing exceptions to the geometric design criteria in Part V.

### 40-8.01 Department Intent

The general intent of the Indiana Department of Transportation is that all road design criteria in Part V of this *Manual* should be met and that, wherever practical, the proposed design should exceed the minimum or lower criteria. In addition, where a range of values is presented, the designer should make every reasonable effort to provide a design which is near the upper value. This is intended to ensure that the Department will provide a highway system which meets the transportation needs of the State and provides a reasonable level of safety, comfort and convenience for the traveling public. However, recognizing that this will not always be practical, the Department has established a process to evaluate and approve exceptions to geometric design criteria.

### 40-8.02 Hierarchy of Design Criteria

#### 40-8.02(01) Level One

Level One controlling design criteria are those highway design elements which are judged to be the most critical indicators of a highway's safety and its overall serviceability. Obviously, not every piece of design information in Part V of the *Indiana Design Manual* qualifies as a Level One criteria. The Department and FHWA have identified the following design elements as Level One and, therefore, the designer must follow the formal documentation and approval process for design exceptions or waivers (Section 40-8.04) when these criteria are not met:

1. design speed (for mainlines and interchange ramps)*;
2. lane widths;
3. shoulder widths for uncurbed sections or curb offsets for curbed sections;
4. bridge width (for new, rehabilitated and existing bridges to remain in place);
5. structural capacity (for new, rehabilitated and existing bridges to remain in place);
6. horizontal curvature (i.e., minimum radius);
7. superelevation transition lengths;

8. the application of stopping sight distance to horizontal curves and vertical curves;
9. maximum grade;
10. travel lane cross slope;
11. superelevation rate;
12. minimum vertical clearance;
13. accessibility requirements for handicapped individuals**; and
14. bridge rail safety performance criteria.

* Exceptions to design speed are not typically allowed. Instead, the designer will normally use the Department's applicable criteria for the project design speed and will, if needed, seek exceptions to those individual design elements which do not meet the project design speed (e.g., a horizontal or vertical curve).

** Requires a waiver, not an exception. See Section 40-8.04(01).

**40-8.02(02) Level Two**

Level Two are design criteria which are judged to be important indicators of a highway's safety and serviceability but are not considered as critical as the Level One criteria. When the Department's criteria for Level Two are not met, the designer will document in the project file that the criteria have not been met and provide a brief rationale for not meeting the Level Two criteria. However, it is not necessary to prepare in-depth documentation to justify the decision.

The brief rationale for a project's inaccordance with the intersection sight distance requirements should include the following:

1. state the project design speed;

2. summarize accident data for the most recent available 3-year period;

3. evaluate the accident data which is related to intersection sight distance; and

4. approximate the cost of accordance with the intersection sight distance requirements.

For local-agency projects, the local agency should furnish written concurrence with any decision not to improve the intersection sight distance to full accordance with the requirements. This concurrence may be in the form of a local elected official's signing off on the Level Two design exception, or a separate letter from the elected official.

The following lists the Level Two design criteria:

1. all roadside safety design elements (see Chapter Forty-nine);

2. the obstruction-free zone on 3R non-freeway projects;

3. median and side slope rates;

4. access control for freeways and for freeway ramp intersections with non-freeway facilities;

5. intersection sight distance;

6. freeway acceleration lane length;

7. freeway deceleration lane length;

8. median width;

9. shoulder cross slope and rollover;

10. auxiliary lane and shoulder width on non-freeways;

11. minimum grade (for drainage);

12. minimum level of service criteria;

13. parking lane width;

14. two-way left-turn lane width;

15. critical length of grade; and

16. truck SSD for specific applications (see Section 42-1.0).

**40-8.02(03) Level Three**

Level Three includes all design criteria not listed in Levels One and Two. No action is required when Level Three criteria are not met; however, the designer should informally notify his/her supervisor of the situation.

## 40-8.03 Design Exception Process

The design exception process will be applied as follows:

1. Project Scope of Work. The design exception process will apply to new construction, reconstruction (4R), 3R / partial reconstruction freeway and 3R non-freeway projects. The application of the design exception process to resurfacing projects is discussed in Chapter Fifty-six. The design exception requirements do not apply to high-accident location projects on non-NHS routes because there are no specific design criteria. The design exception process does not apply to signing and pavement markings, signal installation and traffic barrier projects which require little or no roadway work.

   Generally, the design exception process does not apply to preventative maintenance projects on the National Highway System. No exceptions are needed on these projects for the retention of existing features which do not meet INDOT criteria. In effect, INDOT is maintaining the project as built and as agreed to with FHWA in the project agreement. However, any new design features which do not meet INDOT criteria created by the project, or existing ones made worse, must be covered by an exception, because such action in effect changes the project as built. Preventative maintenance includes restoration and rehabilitation of specific elements of a highway facility when it can be demonstrated that such activities are a cost-effective means of extending the service life of the existing facility. Typical preventative maintenance treatments are listed in Section 52-3.0.

2. Federal-Aid Projects on the National Highway System. On these projects, design elements not meeting the criteria for Level One design elements will follow the procedures in Section 40-8.04. For Level Two design exceptions, the designer should inform FHWA of the exception on those projects which are not exempt from FHWA oversight.

3. State-Funded Projects, FHWA Oversight Exempt Projects, and Projects Not on the NHS. All design elements on these projects, including State highways and local roads, not meeting the criteria for Level One should be documented and approved as an INDOT exception. Where the Level Two criteria will not be met, the designer will document in the project file that the criteria have not been met and provide a brief rationale.

4. Locally Funded Projects. On 100% locally funded projects, it is desirable that the designer document where the proposed design deviates from the criteria provided in Part V.

5. Signing and Dating Design Exception Request. For Level One and Level Two design exception requests, the designer should sign and date the request. A consultant, if used, should also include the name of the consulting firm below the signer's name.

## 40-8.04 Procedures for Design Exceptions (Level One)

The designer will not request an exception to the Level One design criteria until he/she has fully evaluated the impacts of the proposed design (i.e., the exception) and the associated impacts of fully meeting the Level One criteria. The evaluation process shall include obtaining comments and approval recommendations from the applicable sections including:

1. Design Division Utilities Unit (Supervisor),
2. Design Division Railroad Unit (Supervisor),
3. Design Division Hydraulics Unit (Supervisor),
4. Contracts and Construction Division Standards Section (Manager),
5. Land Acquisition Division Engineering Section (Manager),
6. Materials and Tests Division Geotechnical Section (Manager),
7. Operations Support Division Traffic Specialist, and
8. Environment, Planning and Engineering Division Engineering Assessment Section (Manager).

After review by the applicable sections, the design exception shall then be routed in the order shown below for further comments, recommendations and final action:

1. Designer's Section Manager, and
2. Design Division Chief.

### 40-8.04(01) Department Procedures

All design elements not meeting the Level One criteria will require a formal, written INDOT exception. These include all paving exceptions, S-lines and traffic maintenance phases. See the Level One Design Exception Checklist on the Department's website, at http://www.ai.org/dot/div/contracts/design/pdf/levelonecriteria/pdf . All design exceptions for a project may be included in one document. The following will apply.

1. All Level One Criteria (Except Handicapped Accessibility). Except for the handicapped accessibility requirements, the written design exception request will, at a minimum, address the following:

a. Project Description. Project location, functional classification, description of work and type of area (residential, commercial, rural, etc.) in which the project is located.

b. Design Feature. Description of the design feature that does not meet the Department's criteria.

c. Construction Costs. The additional cost to construct the feature to meet the Department criteria.

d. Project Design. Basic design parameters of project (e.g., current and projected 10-year and 20-year traffic volumes, design speed, posted speed, percent trucks).

e. Accident Analysis. In addition to furnishing the computer printout of accident experience for the previous 3-year period, the accident data must be:

- Summarized accident experience must be described in general terms (e.g., type, severity, contributing circumstances).

- Analyze and evaluate the accident experience which is related to the design feature which does not meet Department criteria. The evaluation may include, for example, a comparison of the accident rate on the highway to the State-wide rate for that type of facility or may include a statistical analysis of the accident experience at the location of the design feature (e.g., a horizontal curve).

f. Cost-Effective Analysis. In many cases, the designer will be required to conduct a cost-effective analysis to justify the proposed design. See Chapter Fifty for more information.

g. Ancillary Impacts. The designer must evaluate and document any adverse effects the design exception will have on any other design elements.

h. Safety. The designer must evaluate and document the safety impacts of the design exception.

i. Remedial Actions. The designer must document the proposed remedial actions which will be implemented to alleviate the retention or construction of the design feature which does not meet Department criteria (e.g., traffic control devices).

j. Other Factors. Other factors which may have an effect on the final recommendation should be discussed. For example:

(1) projected service life of facility after construction is completed,
(2) compatibility with adjacent sections of the proposed project,
(3) probable time before reconstruction of the section is anticipated, and
(4) environmental and right-of-way impacts of meeting the Department criteria.

A design exception for a local agency project or a state project involving an element on a local agency's road should be signed by the local elected officials who have jurisdiction of the project or road.

Within INDOT, the final approval of the design exception is the responsibility of the Design Division Chief. The request for a design exception will be submitted by Department memorandum to the Design Division Chief for review and approval. For further information regarding approval of Level One design exception requests, see the notes or statements associated with the Design Tables in Chapter Fifty-three, Section 54-2.0, and Section 55-3.0.

2. Handicapped Accessibility. The following will apply to a request for a waiver to the handicapped accessibility requirements:

a. All Federally Funded Projects (Including Those Projects Exempt From FHWA Oversight). A waiver of the *Americans With Disabilities Act* (ADA) requirements, rather than a design exception, is required when it is not considered practical to comply with a specific design element of the ADA. The waiver request must be submitted to FHWA for their review. They will forward the request to the Architectural and Transportation Barriers Compliance Board (ATBCB) for approval.

The content of the waiver request will vary depending on the design element. However, it must be clearly demonstrated that it is not practical to comply with the ADA requirements. There must be sufficient information submitted so that the ATBCB can readily make their decision without asking for more information. For example, if the 2% sidewalk cross slope cannot be maintained across several driveways on a project, it would be reasonable to submit the following information:

(1) a set of plans showing the location of each driveway and the profile grade of the driveway,

(2) the station (R) or (L) of centerline of each driveway,

(3) the street address for each affected property,

(4) the sidewalk cross slope that is proposed across each of the affected driveways,

(5) the work that would be required to achieve the 2% cross slope, and

(6) the cost of achieving the 2% cross slope at each driveway.

b. All State and Local Projects With No Federal Funds Involved. If it is not practical to comply with the ADA requirements on any of these projects, it will be necessary to document the project files with the appropriate justification. The justification must demonstrate that it is not practical to comply with the ADA. The documentation should be in sufficient detail for later use, if necessary, as the basis for a defense in case of a complaint or litigation.

**40-8.04(02) FHWA Procedures**

All proposed exceptions to the Level One criteria that are on the Interstate system that are not exempt from FHWA oversight must be submitted to the FHWA Indiana Division's Administrator for review and approval. The proposed exceptions on Federal-aid projects will not be submitted to FHWA until after the exception has completed the internal Department process (Section 40-8.04(01)). The documentation required for the Department's exception process will usually be sufficient for FHWA evaluation.

For Level Two design exceptions, the designer should inform FHWA of the exception on non-exempt Interstate system projects.

**40-8.04(03) Procedures for the Defense Highway Network (Interstate System) – Vertical Clearance**

The Design Division Chief can only take approval action on design exceptions to reduce or retain the existing vertical clearance over the Interstate system that is less than the required 4.9 m after coordinating formally with the Military Traffic Management Command Transportation Engineering Agency (MTMCTEA) of the Department of Defense (DOD). This coordination is necessary whether it is a new construction project, a project that does not provide for correction

of an existing substandard condition, or a project that creates a substandard condition at an existing structure. The requirement to provide or preserve the 4.9 m vertical clearance extends to the full roadway width including shoulders for the through lanes, as well as to ramps and collector-distributor roadways in Interstate-to-Interstate interchanges. This requirement applies to the Indiana Toll Road since it is part of the Interstate System.

The Design Division Chief will coordinate directly with DOD by sending the design exception recommendation and a response date to:

Director
Military Traffic Management Command
Transportation Engineering Agency (MTMCTEA)
ATTN: MTTE-SA
720 Thimble Shoals Boulevard, Suite 130
Newport News, Virginia 23606-2574
(Telephone: (757)-599-1117, FAX: (757)-599-1560)

A response time of 30 days after being sent from INDOT should allow an adequate review period for the MTMCTEA. The MTMCTEA should verify receipt of the INDOT request by telephone or FAX to the appropriate design engineer named in the transmittal letter (see Figure 40-8A, MTMCTEA Design Exception Request Letter).

If the MTMCTEA does not reply by the response date, it will be assumed that they have no concerns with the proposed design exception. If the MTMCTEA reply does not agree with the design exception, INDOT personnel should consider any feasible mitigation measures and notify the MTMCTEA of the proposed action.

On non-exempt projects, INDOT personnel should work jointly with the FHWA in determining proposed mitigation measures. The content of the submission to the MTMCTEA should include the information required in Section 40-8.04(01).

In addition to the above information, the submission should also include preliminary plan and profile sheets for both the Interstate highway and the overpassing structure.

Coordination with the MTMCTEA is to be completed before sending the design exception to the FHWA on non-exempt projects. The submission to the FHWA should include documentation that the coordination with the MTMCTEA has been satisfactorily completed.

**40-8.04(04) Procedures for Local Projects (with Federal Funds)**

For local projects with Federal funds, design exception requests will be made by letter to the Design Division Chief.

### 40-8.04(05) Procedures for 100% Local Projects

For projects funded entirely with local funds, INDOT recommends that the local agency establish a procedure so that an individual with the proper authority will approve any design exceptions.

### 40-8.04(06) Signature Block

The Design Division Chief is responsible for the approval of all proposed exceptions to the Level One criteria for exempt projects on the NHS system and all Federal-aid projects on non-NHS routes. The Design Division Chief must also approve in design exceptions on Federal-aid projects on the NHS that are not exempt from FHWA oversight before the exception is submitted to FHWA for its approval. In addition, the Design Division Chief is responsible for any approval of design exception requests on 100% State-funded projects. Each design exception request will contain a block for an approval signature at the bottom of the letter/memorandum. Use this format.

1. For Federal-Aid Projects on the NHS that are Not Exempt From FHWA Oversight:

   Approved: _____ Date: _____
   Chief, Design Division

   Approved: _____ Date: _____
   Division Administrator
   Federal Highway Administration

2. For All Other Projects, Except 100% Locally Funded Projects:

   Approved: _____ Date: _____
   Chief, Design Division

## 40-8.05 Documentation

Figure 40-8B should be used to document the project's adherence to the Department's Level One design criteria. This applies to all projects, even if there are no design exceptions. The designer should fill in the appropriate boxes on the form. Note that the determination of whether or not the proposed project design meets INDOT design criteria is dependent upon the project scope of work and the design criteria described in this *Manual*. If, for example, a 3R non-freeway project is under design, Chapter Fifty-five will apply